SYSTEMATICS OF *PATERSONIA* (IRIDACEAE, PATERSONIOIDEAE) IN THE MALESIAN ARCHIPELAGO[1]

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Abstract

The predominantly Australasian genus *Patersonia* R. Br. (Iridaceae, Patersonioideae) includes 18 species in Australia, one in New Caledonia, and just one currently recognized species in the Malesian archipelago, although two more have been described previously but are now reduced to synonymy. After examining the available collections of the genus from this vast area, I have identified two distinct sets of populations in Borneo, two more in New Guinea, one in Sumatra, and one in Mindoro, The Philippines. Many collections lack flowers or are poorly preserved, yet greater-than-expected differences in vegetative and some fruit features for a single species are evident among the six population sets. Morphological variation includes leaf size; marginal vestiture and microscopic surface structure; flowering stem orientation, width, and length relative to leaves; inflorescence spathe and floral bract vestiture; and absence or presence and type and amount of pubescence on perianth tube and ovary. Recognition of just one hypervariable Malesian species does not adequately reflect the biological situation. I propose the following: recognition of *P. borneensis* Stapf and the west New Guinean *P. novo-guineensis* Gibbs, currently subsumed in *P. lowii* Stapf; addition of a second species in Papua New Guinea, *P. inflexa* Goldblatt; and treatment of the Sumatran highland plants as *P. sumatrensis* Goldblatt from Indonesia. Philippine plants from Mindoro match none of these and represent another species, *P. philippinensis* Goldblatt. Lectotypes are designated for the two names *P. lowii* and *P. novo-guineensis*. This taxonomy awaits provenance of flowers with well-preserved perianths of all but *P. lowii* and *P. borneensis* and capsules and seeds of *P. philippinensis*, but are unlikely to alter this treatment. Floral differences among most *Patersonia* species are small, except for the vestiture on tepals and tube visible in many of the available specimens, and for the most part involve only modest differences in size and color of the tepals.

Key words: Indonesia, Iridaceae, Malaysia, Malesia, Papua New Guinea, *Patersonia*, The Philippines, Sumatra, West Papua.

The Australasian and Malesian *Patersonia* R. Br. (Iridaceae), the only genus of Patersonioideae (Goldblatt et al., 2008), is centered in Australia, where 18 species are recognized (Cooke, 1986; Keighery, 1990). One species, *P. neocaledonica* Goldblatt & J. C. Manning, is restricted to New Caledonia (Goldblatt et al., 2011), and one more, *P. lowii* Stapf from Sabah, Malaysia, is currently recognized in the Malesian archipelago, but two more have been described: *P. borneensis* Stapf, from Mt. Kinabalu, Borneo, and *P. novo-guineensis* Gibbs, from western New Guinea. Both latter names were reduced to synonymy in *P. lowii* by Geerinck (1977) for the *Flora Malesiana*. This treatment was followed by Van Royen (1979) and Beaman and Beaman (1998), respectively, in their floristic accounts for New Guinea and Mt. Kinabalu, Borneo.

Patersonia comprises mostly evergreen, tufted perennials with creeping rhizomes, which bear a 2-ranked fan of unifacial leaves and produce unbranched, leafless flowering stems seasonally, each bearing a terminal inflorescence, a binate rhipidium (Goldblatt, 1990; Goldblatt & Manning, 2008). The deciduous geophyte *P. babianoides* Benth. has a single leaf and a fleshy rhizome that produces annual, cormlike segments. Just three species, *P. glabrata* R. Br., *P. pygmaea* Lindl., and *P. spirafolia* Keighery, have woody, leafy stems, a habit thus resembling a low shrub. All Malesian populations of *Patersonia* have the more common tufted growth form.

Flowers of all *Patersonia* species are surprisingly similar: the inflorescence, a binate rhipidium, is enclosed by a pair of large leafy bractlike structures, the spathes. Individual flowers, each subtended by a dry, membranous bract, are sessile, have a narrowly ellipsoid ovary about half as long as the spathes and a slender tube that serves the function of a pedicel, raising the flower from the spathes. The flowers are fugaceous, lasting just a morning each, and have large, spreading outer tepals colored blue to mauve, sometimes white or partly white with a blue center. The inner tepals are reduced in size, most often represented by linear spreading cusps, or are absent. The Australian *P. umbrosa* Endl. and the New

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Caledonian *P. neocaledonica* are exceptional in having lanceolate inner tepals about one third as long as the outer tepals. *Patersonia umbrosa* var. *xanthina* (F. Muell.) Domin stands out in having yellow flowers. The filaments are partly to fully united in a column, and the style divides opposite the anther apices, or sometimes beyond them, into three broad stigmatic lobes. The capsular fruits are ellipsoid and fully dehiscent but are retained within the spathes.

Except for Stapf's (1894) careful analysis of collections of the two species on Mt. Kinabalu, Borneo (now Sabah, Malaysia), *Patersonia* in the Malesian area has received little critical study. Part of the reason is that collections have been slow to accumulate, and none that I have seen include carefully pressed flowers. Despite these handicaps, there are several distinctive characters among the available collections at several herbaria (mainly CANB, GH, K, L) that cast doubt on their treatment as a single species.

Of the two named species from Borneo, both on the Mt. Kinabalu massif, *Patersonia borneensis* and *P. lowii*, the first is relatively tall, reaching to 60 cm (Table 1), and has leaves exceeding the stem and rhipidia, and the second, about half as tall, has a stem about as long as the leaves, sheathed by the uppermost leaf close to the base of the rhipidium. Leaves of *P. borneensis* are closely ribbed, lack marginal tomentum but are usually minutely papillate when viewed at high magnification (above 20×). In contrast, in *P. lowii*, which has striate leaves (when dry), the margins are usually brown-tomentose, and the leaf surface lacks papillae. The keels of the outer rhipidial spathes and margins of some of the floral bracts are also sparsely brown-tomentose, whereas the spathes and bracts of *P. borneensis* are glabrous.

The flowers of the two species, carefully dissected by Stapf and illustrated in his 1894 paper, are similar, but those of *Patersonia borneensis*, described by collectors as purplish white, lack inner tepals and have entire, obovate stigmatic lobes. Flowers of *P. lowii*, evidently blue or purple, are shown in his drawing as having vestigial, cusplike inner tepals. Stapf, however, was uncertain on this point, and in his description (1894: 241) used the words "lobi . . . nullo (?)" and described minutely crenulate stigmatic lobes. The slender perianth tube is 25 mm (1 inch) long in *P. borneensis* and 22 mm ("11 lin[es]") long in *P. lowii*. Not noted by Stapf, the perianth tube of *P. borneensis* bears scattered branched hairs (Table 1).

Plants from western New Guinea, now West Papua, Indonesia, and adjacent western Papua New Guinea, described by Gibbs (1917) as *Patersonia novo-*

Table 1. Comparison of critical taxonomic characters of Malesian *Patersonia* species.

	Leaf dimensions and surface	Leaf margins	Stem flexure, height and width	Spathe keels and floral bract margins	Perianth tube tomentum
P. borneensis Stapf	42–60 cm × (3–)4–6 mm; ribbed, papillate	smooth	straight; 42–55 cm × ca. 1.5 mm	smooth	scattered multicellular hairs
P. lowii Stapf	15–30 cm × 3–4 mm; striate, smooth	densely brown to brown-tomentose	straight; 15–30 cm × ca. 1.5 mm	brown-tomentose on spathe keels and some bract margins	somewhat smooth or sparsely white-hairy below
P. inflexa Goldblatt	10–22 cm × 2–3(–4) mm; striate, smooth	white, sometimes brown-ciliate	usually strongly flexed; 12–20 cm × ca. 1.5 mm	smooth	brown-tomentose in lower half
P. novo-guineensis Gibbs	15–30 cm; striate, smooth	brown-tomentose	straight; (5–)10–20 cm × ca. 2 mm	brown-tomentose on spathe keels and some bract margins	brown-tomentose in lower half
P. philippinensis Goldblatt	90–120 × 2.0–3.5 mm; smooth	slightly thickened, smooth	straight, 10–12 cm × 0.8 mm	smooth	unknown
P. sumatrensis Goldblatt	12–25 cm; striate-smooth	smooth	weakly flexed; 18–35 cm × ca. 1.5 mm	smooth	smooth

guineensis, resemble *P. lowii* in general aspect and have, like that species, brown-tomentose leaf margins and sometimes tomentose spathe keels and bract margins or tips. Gibbs (1917: 101) distinguished her species by the particularly conspicuous brown marginal tomentum ("matted branched hairs") and white or pale mauve flowers. The inner tepals are lacking, and the outer tepals have a conspicuous apical tuft of hairs. Unlike *P. lowii*, the perianth tube usually bears a tomentum of dark brown, branched hairs, denser in the lower half of the tube.

Populations from eastern Papua New Guinea have flowers described as mauve or blue, the outer tepal tips lack a terminal tuft of hairs, and although plants superficially resemble *Patersonia lowii* and *P. novo-guineensis* in their low stature, the uppermost leaf reaches only to the middle of the stem, which is flexed outward above the sheath of this leaf. The feature is so marked that the stem was noted by one collector (*Woods 2627*, holotype, NSW) as "curved into a horizontal position." The leaf margins in all collections that I have seen are minutely pale-ciliate, occasionally turning brown, but the spathes and bracts are smooth. Notable in these plants are branched, dark brown hairs at the distal end of the ovary and lower perianth tube, densest near the ovary apex.

Plants from northern Sumatra, on Gunung Leuser (also called Mt. Loiser) in the Gunung Leuser Nature Reserve, represent another variant. They have the low stature and general appearance of *Patersonia lowii*, but the leaves and spathes are glabrous, lacking even a trace of marginal cilia. However, the stems are flexed above the sheath of the uppermost leaf, but the feature is less pronounced than in the eastern Papua New Guinea plants. Flower color was variously described by collectors as lilac, lilac-blue, or bluish.

Last, *Patersonia* has also been recorded from the Philippines, where Merrill (1907) identified a collection from Mt. Halcon, Mindoro, as *P. lowii*. Recently, the genus has been reported from Mt. Hamiguitan, Mindanao (Amoroso et al., 2009), also as *P. lowii*. The Mindoro plants are smaller than any from elsewhere in Malesia, no more than 15 cm high, and the leaf margins, spathe keels, and floral bract margins are smooth, thus unlike those of *P. lowii*. No specimens of the Mindanao plants were evidently collected, or they have not been made available to me despite requests.

The range of morphological variation among the populations of *Patersonia* in the Malesian Archipelago is greater than one would expect in a single species, and I have no hesitation in recognizing all three of the Malesian species described to date. I also consider it advisable to accord species rank to plants from Sumatra (*P. sumatrensis* Goldblatt), eastern Papua New Guinea (*P. inflexa* Goldblatt), and Mindoro (*P. philippinensis* Goldblatt). They can readily be keyed out on vegetative features, and these characters are consistent with those floral or fruit differences that can be seen in the available specimens, notably ovary and perianth tube vestiture.

REVIEW OF MORPHOLOGY IN MALESIAN *PATERSONIA*

Leaves are narrowly sword-shaped to linear. The narrow hyaline margins are smooth in *Patersonia borneensis*, *P. sumatrensis*, and *P. philippinensis*, white to brown ciliate in *P. inflexa*, and brown-tomentose in *P. lowii* and *P. novo-guineensis*. When dry, the leaves are striate (perhaps an artifact of drying, the ridges merely representing the leaf veins) and smooth, except in *P. borneensis*, which has ribbed leaves and a papillate surface visible only at greater than 25× magnification. The leaves are typically about as long as the stems, sometimes exceeding them, notably so in *P. borneensis* and *P. philippinensis*. Stems are erect or, in *P. inflexa* and to a lesser extent in *P. sumatrensis*, flexed above the sheathing portion of the uppermost leaf, leaving the stem and rhipidium inclined to almost horizontal. The rhipidial spathes are noted in some collections to be colored shades of brown (purple-brown, orange-brown, red-brown), and I assume brownish-colored spathes for all Malesian species (also a feature of 12 Australian species). The keels of the spathes of *P. lowii* are partly brown-tomentose, especially toward the tips. In *P. novo-guineensis*, the bract tips bear a tuft of branched hairs.

Flowers are typical of the genus, always shades of blue-mauve to lilac or described as sometimes white. The inner tepals are said to be absent in *Patersonia borneensis*, but drawings for *P. lowii* by Stapf (1894) show vestigial inner tepals represented by linear cusps ca. 5 mm long. I assume the inner tepals are vestigial (perhaps absent) in the remaining Malesian species. The perianth tube of *P. inflexa* and *P. novo-guineensis* bears a dense tomentum of branched, brown hairs. In *P. sumatrensis*, the perianth tube is smooth; in *P. borneensis* and *P. lowii*, it has a few, scattered hairs, white or brown in color. Details of the androecium and gynoecium are known only for *P. borneensis* and *P. lowii* from Stapf's (1894) drawings of his careful dissections. The filaments are completely united in a column, and the ovary is smooth, or in *P. inflexa* bears branched hairs.

The capsules are smooth—or in *Patersonia inflexa*, tomentose near the apex—and show the outline of the seeds at maturity. Seeds, known in four species, are ellipsoid, dark brown (not black as described by Stapf [1894], for *P. borneensis*), and shiny, and show the outlines of elongate surface cells below the translucent cuticle. A flattened, white aril, or perhaps more correctly a caruncle (defined as an aril-like outgrowth arising from the mouth of the micropyle, the apparent condition in *Patersonia*), is present at the micropylar end, largest in *P. sumatrensis* and twisted and appressed, flattened and twisted in *P. borneensis*, round or elongate and curved in *P. novo-guineensis*, and in *P. inflexa*, tapering, distally linear and appressed. Seeds of *P. inflexa* have a small hook at the micropylar end. Only one or at most two collections of any species have mature seeds, so variation for caruncle shape cannot be assessed. Seeds of *P. lowii* and *P. philippinensis* are unknown.

Seeds of six Australian species of *Patersonia* are reported to have white, so-called arils (Cooke, 1986) and have been described either as cylindrical with linear appressed arils (*P. juncea* Lindl., *P. pygmaea*), compressed-ovoid and brown (*P. inaequalis* Benth.), or black (*P. fragilis* (Labill.) Asch. & Graebn., *P. drummondii* F. Muell. ex Benth., *P. glabrata*). The aril color, white, is noted only in *P. fragilis*. Except for the absence of an aril (more accurately, the caruncle), the seeds of *P. occidentalis* R. Br. (illustrated in Cooke, 1986: frontispiece) closely resemble those of the Malesian species in color, texture, and shape (described as compressed-ovoid, thus equivalent to the term "ellipsoid," as used herein).

IUCN Red List category. Although I have no personal field knowledge of *Patersonia*, I offer the following observations on the conservation status (sensu IUCN, 2001) of the genus in the Malesian area. All populations grow at high elevations, mostly above 2000 m, and away from human habitation, and thus are minimally affected by human activity. Populations in Borneo, the Philippines (both Mindanao and Mindoro), and Sumatra are in official nature reserves, national parks, or conservation zones. In New Guinea, *P. novo-guineensis* is relatively widespread, but *P. inflexa* appears to be a relatively narrow endemic. Nevertheless, no species is currently under any conceivable threat. Like other high mountain species, however, global warming may open their habitats to species today confined to lower, warmer elevations, increasing competition for habitat and possibly driving *Patersonia* populations to higher elevations.

Geographic Observations

Populations of *Patersonia* in Malesia are confined to the higher mountains of the archipelago. All species occur at elevations above 1500 m and, except for *P. lowii*, above 2000 m. All six species are allopatric and except for *P. borneensis* and *P. lowii* (both on Mt. Kinabalu but at different elevations) are isolated by substantial distances of some hundreds of kilometers. The Philippines sites for the genus on Mindoro and Mindanao are some 900 km from the next nearest station for the genus, Mt. Kinabalu. Gunung Leuser in northern Sumatra is over 2000 km from Mt. Kinabalu and even farther from the nearest New Guinea population. Such long-distance dispersal is remarkable in the Iridaceae where few genera, including *Patersonia*, have adaptations for dispersal over long distances. *Patersonia* seeds are 2–3 mm long in the Malesian species known for this organ and bear small white caruncles, which I infer are adaptations for local dispersal by ants. The center of diversity for *Patersonia* is undoubtedly Australia, where it is widespread, but it is most diverse in Western Australia (Cooke, 1986). It seems most reasonable to postulate dispersal from Australia, first to New Guinea sometime after that landmass rose above sea level in the Middle Miocene, and then to high mountains in Mindanao and Borneo, some 1500 km distant, reaching Sumatra last, the most distant from any recorded station for the genus. Other high mountains in Malesia may well harbor *Patersonia*. Those on several islands—notably Celebes, Java, and Timor—reach elevations above 2500 m. There are no comparable radiations in Iridaceae, but the predominantly African genera *Gladiolus* L. (ca. 265 spp.), *Moraea* Mill. (ca. 210 spp.), and *Romulea* Maratti (ca. 90 spp.) each have species throughout sub-Saharan Africa and just a handful in Eurasia; these are thought to be descended from single introductions, at least in *Gladiolus* and *Moraea*, from ancestors in southern Africa (Goldblatt et al., 2002; Valente et al., 2011). The small morphological differences among the Malesian species of *Patersonia* likewise suggest a single introduction from the south. Based on molecular clock estimates, *Patersonia* diverged from its immediate sister lineage ca. 55 million years ago (Ma) (Goldblatt et al., 2008). The genus was thus established in Australia long before the Malesian Archipelago was available for colonization. Again based on morphology, dispersal of *Patersonia* to New Caledonia was likely an independent event.

Taxonomic Treatment

Patersonia R. Br. in Ker Gawl., Bot. Mag. 26: tab. 1041. 1807, nom. cons., non *Genosiris* Labill., Nov. Holl. Pl. 1: 13. 1805. TYPE: *Patersonia sericea* R. Br.

KEY TO THE MALESIAN SPECIES OF *PATERSONIA*

1a. Abaxial and sometimes adaxial leaf margins above the level of the sheath densely tomentose with dark brown, branched hairs; distal parts of spathe keels and often floral bract tips or distal margins hairy.
  2a. Outer tepals with a tuft of branched hairs at apices; perianth tube usually densely tomentose or sometimes sparsely hairy to ± smooth (perhaps by abrasion), with brown, branched hairs .... 4. *P. novo-guineensis*
  2b. Outer tepals without hairs at tepal apices; perianth tube sparsely hairy or evidently smooth .... 3. *P. lowii*
1b. Leaf margins smooth or bearing minute translucent or brown cilia; spathe keels and bract margins and apices glabrous.
  3a. Plants small, mostly 8–12 cm high; leaf blades 2.0–3.5 mm wide; inner rhipidial spathes 23–30 mm ... . 5. *P. philippinensis*
  3b. Plants medium-sized to relatively large, mostly 18–60 cm high; leaf blades 2–6 mm wide; inner rhipidial spathes 35–50 mm.
    4a. Leaf blades closely ribbed and minutely papillate (30× magnification); flowering stem ± erect throughout and shorter than leaves; perianth tube sparsely hairy (or smooth due to abrasion)........ .... 1. *P. borneensis*
    4b. Leaf surface smooth or occasionally obscurely papillate (30× magnification) and striate to obscurely ribbed when dry; perianth tube smooth or densely woolly hairy.
      5a. Perianth tube and usually distal part of ovary with a dense tomentum of branched, brown hairs; stem flexed outward above sheath of uppermost leaf, nearly horizontal; leaf margins bearing white or occasionally brown cilia .... 2. *P. inflexa*
      5b. Perianth tube and ovary smooth; stem erect or slightly flexed above sheath of uppermost leaf; leaf margins lacking cilia .... 6. *P. sumatrensis*

1. Patersonia borneensis Stapf, Trans. Linn. Soc. London, Bot., ser. 2, 4: 242. 1894. TYPE: Malaysia. Sabah: Mt. Kinabalu, Temburungo, 7700 ft. [ca. 2300 m], 1892; *G. D. Haviland 1179* (holotype, K [barcode] 000523994!; isotype, K [barcode] 000523995!).

Tufted perennials 35–60 cm high; stems compressed, oval in section, 42–55 cm, ca. 1.5 mm diam., ± erect throughout, shorter than leaves. Leaves many, basal, usually slightly exceeding stems; blades 4–6 mm wide, closely ribbed, minutely papillate (30× magnification), margins smooth; the uppermost leaf sheathing stem to about midstem, the apex rarely reaching base of spathes. Rhipidial spathes 36–50 mm long, subequal or inner slightly longer, brownish purple, keels and margins smooth; floral bracts dry-membranous, protruding a short distance from spathes, margins smooth. Flowers pale lavender to blue-purple (also described as whitish purple); perianth tube ca. 25 mm, with sparse, branched hairs especially in lower half or smooth due to abrasion; outer tepals ovate, ca. 15 mm, inner tepals lacking; filaments united in a column ca. 1 mm; anthers ca. 2 mm long; ovary ellipsoid, 18–23 mm, smooth; style dividing at apex anthers, stigma lobes obovate. Capsules ellipsoid, 20–25 mm, smooth, narrowed in proximal 5 mm and without seeds; seeds ellipsoid, dark brown, shiny, 2.5–3 × 1 mm, micropylar caruncle white, flattened and twisted, ca. 0.5 mm long. Flowering mainly in December to April.

Discussion. Restricted to high elevations on the Mt. Kinabalu massif in Sabah, Malaysia, *Patersonia borneensis* stands out in being the tallest of the Malesian species of the genus, as tall as 60 cm. The leaves, which exceed the flowering stems, have smooth margins, and the spathe keels and margins and the floral bract margins likewise lack vestiture of any kind (Table 1). The leaves are, however, closely ribbed and visibly papillate under greater than 25× magnification, unique for the Malesian species. This stands in marked contrast to the other Mt. Kinabalu species, *P. lowii*, which has brown-ciliate to brown-tomentose leaf margins, the leaf surface also striate but smooth, usually the keels and upper margins of the spathes brown-ciliate to tomentose, and floral bracts with margins and tips brown-tomentose. The flowers of the two species are broadly similar, *P. borneensis* having the slender perianth tube ca. 25 mm long and bearing scattered branched hairs in the lower half, whereas *P. lowii* has a perianth tube ca. 22 mm long, smooth or with scattered, apparently unbranched hairs in the lower half. The stigma difference noted by Stapf, smooth in *P. borneensis* but crenulate in *P. lowii*, may be significant but should be confirmed when more flowering specimens become available, as should the possible presence of vestigial inner tepals in the latter.

The above differences provide ample grounds for regarding *Patersonia borneensis* as distinct from *P. lowii*. In addition, current records of *P. borneensis* are all from higher elevations than *P. lowii*, 2000 m and above (2200–2750 m), whereas the few records of *P. lowii* are from no higher than 1675 m. This suggests that the two species have different ecology and habitat preferences.

Additional specimens examined. MALAYSIA. **Sabah:** Mt. Kinabalu, E shoulder, on ridge in dry places, *W. L. Chew, E. J. Corner & A. Stainton 996* (K, L); upper

Kinabalu, *J. Clemens & M. S. Clemens 30061* (GH, K, L, UC); *J. Clemens 50981* (NY); upper Kinabalu, Kamberanga, *J. & M. S. Clemens 30951* (NY); *M. S. Clemens 10545* (UC); Kinabalu, Kamburangah, *L. S. Gibbs 3124* (BM, K); Mt. Kinabalu, Garulu spur, open places in mossy forest, *J. & M. S. Clemens 51034* (BM, GH, K, L, UC); Kalabit Highlands, Mt. Murud, slope with open shrubby vegetation, *H. P. Nooteboom & P. Chai 20256* (BISH, CANB, K, L).

2. **Patersonia inflexa** Goldblatt, sp. nov. TYPE: Papua New Guinea. Milne Bay: Mt. Dayman area, Donana, 7500–8000 ft. [2285–2440 m], subalpine grassland with moss, forest edge, 24 July 1968 (fl.), *P. J. B. Woods 2627* (holotype, NSW!; isotypes, GH!, K!, L!).

Plantae *Patersoniae lowii* Stapf similes, sed ab ea foliis 2–3(–4) mm latis marginibus minute ciliatis, spathis subaequalibus 35–43 mm longis carinis marginibusque laevigatis, tubo perianthii ca. 25 mm longo dense tomentoso atque ovario ca. 14 mm longo distinguuntur.

Tufted perennials 15–22 cm high; stems compressed, reddish brown, oval in section, 12–20 cm × ca. 1.5 mm, flexed outward above sheath of uppermost leaf and nearly horizontal. Leaves 8 to 10 per shoot in 2 ranks, basal, usually slightly shorter than flowering stem (or slightly longer); blades 2–3(–4) mm wide, when dry closely striate, smooth (30× magnification), margins translucent (white when dry) or sometimes brown-ciliate, uppermost leaf sheathing ca. lower half of stem, blade tip not reaching spathes. Rhipidial spathes reddish brown, subequal, 35–43 mm long, inner 2–3 mm longer than outer, with broad, brown-translucent margins, keels and margins smooth; floral bracts dry-membranous, smooth. Flowers mauve-blue (also described as purple), darker in center; perianth tube ca. 25 mm, densely covered in lower half with branched, brown hairs, denser tomentum toward base, usually extending on distal ovary; outer tepals narrowly ovate, ca. 15 × 7 mm; filaments united in a column ca. 1 mm; anthers ca. 2 mm; ovary ellipsoid, ca. 14 mm, with a tuft of branched hairs near apex; style dividing at apex of anthers, stigma lobes unknown. Capsules ellipsoid, 18–25 mm long, smooth, narrowed in proximal 5 mm and without seeds; seeds ellipsoid, smooth, glossy dark brown, ca. 2 × 1 mm, hooked at micropylar end, micropylar caruncle white, small, flattened, tapering, distally sublinear and appressed. Flowering recorded in June, July, and October.

Discussion. *Patersonia inflexa* is a relatively narrow endemic of the high mountains of eastern Papua New Guinea and, like other Malesian species of *Patersonia*, grows in grassy moorland and subalpine grassland in open habitats. The taxon is most easily distinguished by the characteristic flexed flowering stem, sometimes bent almost horizontally above the sheathing part of the terminal leaf. Unlike the other New Guinea species, *P. novo-guineensis*, the leaves are sparsely ciliate, and the spathe keels and floral bracts are completely smooth. The two New Guinea species share a woolly tomentose perianth tube, the pubescence extending on to the upper part of the ovary in *P. inflexa*. Although seeds are available for few specimens of any Malesian species, those from *Brass 22259* and *Cruttwell 553* show a distinctive hooked micropylar end, not evident in one seed sample each of *P. borneensis*, *P. novo-guineensis*, and *P. sumatrensis*.

P. F. Stevens & J. F. Veldkamp s.n., a collection included here, consists of short, tufted plants ca. 8 cm high with the leaves exceeding the stems, which are straight and sheathed by the uppermost leaf to the base of the spathes. Collected at 3500 m on Mt. Suckling, Papua New Guinea, it may represent a dwarfed, high-elevation variant of *Patersonia inflexa*. More material is needed to investigate this question in more detail.

Paratypes. PAPUA NEW GUINEA. **Milne Bay:** Mt. Maneau, grassy moorland, slopes just below summit, *N. G. Cruttwell 553* (fr.) (K); Mt. Donana, mtn. top moorland, *N. G. Cruttwell 931* (K); Mt. Dayman, Maneau Peak, 2750 m, common in grassland, *L. J. Brass 22259* (fr.) (CANB, K, U); Goropu Mtns. (Mt. Suckling), subalpine grassland, sunny rocky slopes and screes, *J. F. Veldkamp & P. F. Stevens 5636* (BISH, CANB, L, NSW, PNG); Raba Raba, Mt. Suckling complex, S side of Goe Dendeniwa, margins of ultramafic bedrock, *P. F. Stevens & J. F. Veldkamp s.n.* (CANB-244089, L).

3. **Patersonia lowii** Stapf, Trans. Linn. Soc. London, Bot., ser. 2, 4: 241. 1894. TYPE: Malaysia. Sabah: Mt. Kinabalu, NW face, 5000 ft. [ca. 1520 m], s.d., *H. Low s.n.* (lectotype, here designated, K [barcode] 000523997!).

Tufted perennials 15–30 cm high; stems compressed, oval in section, 15–30 cm × ca. 1.5 mm wide. Leaves ca. 9 to 12 per shoot, slightly shorter or slightly longer than flowering stem, 15–30 × 3–4 mm, when dry closely striate, smooth (when viewed above 25× magnification), margins densely brown-ciliate to brown-tomentose, uppermost leaf sheathing fertile stem almost to base of rhipidium, the free blade portion exceeding the spathes. Rhipidial spathes subequal, 36–40 mm long, color unknown, usually keels (not in *Clemens & Clemens 32931*) and often upper margins brown-ciliate to brown-tomentose, lower spathe margins broadly dry-membranous; floral bracts dry-membranous, often with margins and tips brown-tomentose. Flowers blue to purple; perianth tube ca. 22 mm, evidently smooth or sparsely hairy in lower half; outer tepals obovate, 12–14 × 8–9 mm, without hairs at tepal apex; inner tepals ?short, linear cusps ca. 5 mm (from drawing by Stapf, 1894) or ?lacking; filaments united in a column; anthers ca. 3 mm; ovary ellipsoid, ca. 25 mm, smooth; style dividing at apex of anthers, stigma lobes somewhat obovate, minutely crenulate. Capsules and seeds unknown. Flowering recorded in November and March.

Discussion. A narrow endemic of Mt. Kinabalu in Borneo, *Patersonia lowii* is evidently restricted to the Marai Parai (also Maripari) spur. Moderate in height, only 15–30 cm tall, it is recognized by the leaves with brown-ciliate to brown-tomentose leaf margins, a smooth leaf surface, closely striate when dry, and similarly brown-ciliate to brown-tomentose spathe keels and floral bracts. The flowers hardly differ from those of other Malesian species of the genus except for the almost smooth perianth tube, at best sparsely hairy in the lower half, a feature contrasting markedly with *P. novo-guineensis* and *P. inflexa*, which have a woolly perianth tube, and the former also has a tuft of brown hairs on the tepal apices. Other apparently minor floral differences noted above under *P. borneensis* remain to be confirmed. Leaves, spathes, and floral bracts of *P. sumatrensis* lack indumentum of any kind, and leaves of *P. inflexa* are only sparsely ciliate.

Geerinck (1977) included all *Malesian* collections of *Patersonia* in *P. lowii*, noting that, not only was the species (in his broad circumscription) variable for the indumentum, but disjunct populations were not uniform for the character. To the contrary, the Sumatran populations, now *P. sumatrensis*, are quite uniform, and the West Papuan *P. novo-guineensis* is only moderately variable once the eastern Papua New Guinea plants I refer to as *P. inflexa* are treated as a separate species. There is also no overlap in the critical features of *P. borneensis* and typical *P. lowii* although both grow on Mt. Kinabalu. The shorter stature, smooth leaf surfaces, brown-tomentose leaf margins and spathe keels, almost smooth to sparsely hairy perianth tube, and possibly differently shaped stigma lobes readily separate the two. The slightly larger flowers of *P. borneensis*, said to lack inner tepals (probably present in *P. lowii*), may also serve to separate them, but material is too limited at present to rely on this character. It is also significant that records of *P. lowii* are from 1520 to 1675 m, whereas the recorded range of *P. borneensis* is from 2200 to 2750 m. As lectotype for *P. lowii* I designate *Low s.n.*, the better preserved of the two syntypes on which the species was based. Both syntypes are on the same sheet at Kew, *Low s.n.* at left, and *G. D. Haviland 1259* (K [barcode] 000523996) at right.

Additional specimens examined. MALAYSIA. **Sabah:** Mt. Kinabalu, Marai Parai spur, *J. Clemens 248* (GH); *J. Clemens & M. S. Clemens 32931* (K, L, NY); *s.n.* (BM).

4. Patersonia novo-guineensis Gibbs, Contr. Phytogeog. Fl. Arfak Mts., 101. 1917. TYPE: Indonesia. Irian Jaya [as Netherlands New Guinea]: Arfak Mtns., Koebré Ridge, open burnt places on summit, 9000 ft. [ca. 2740 m], Dec. 1913 (fl., fr.), *L. S. Gibbs 5600* (lectotype, designated here, BM!; isolectotypes, K [barcode] 000291969!, L!).

Patersonia novo-guineensis var. *auriculata* Went, Nova Guinea 114. 1924. TYPE. Indonesia. Irian Jaya [as Netherlands New Guinea]: Mamberamo River area, summit of Mt. Doorman, 3320 m, 20 Oct. 1920, *H. J. Lam 1670* (type, L).

Tufted perennials 15–30 cm high; stems compressed, oval in section, (5–)10–20 cm × ca. 2 mm. Leaves usually 8 to 12 per shoot in 2 ranks, ca. as long as or exceeding stems by up to 5 cm, (2–)4–6 mm wide, when dry closely striate, smooth (30× magnification), abaxial and sometimes adaxial margins hyaline and densely brown-tomentose. Rhipidial spathes 28–38 mm long, subequal, inner up to 2 mm longer, spathe margins broadly translucent brown, outer usually brown-tomentose distally, outer spathe keels often densely tomentose; floral bracts dry-membranous, slightly shorter to ca. as long as spathes, some occasionally tipped with brown hairs. Flowers white or pale blue-mauve (also described as purple or violet); perianth tube ca. 20 mm, densely tomentose with branched brown hairs or sometimes sparsely hairy to ± smooth (perhaps by abrasion) (*Kanechira & Hatusima 13663*, *13691*); outer tepals ca. 15 mm, with a tuft of hairs at apices, inner tepals lacking (Gibbs, 1917); filaments united in a column ca. 1.5 mm; anthers 2–3 mm; ovary sessile, ellipsoid, evidently 13–15 mm, smooth; style dividing at apex of anthers, stigma lobes narrowly oblong. Capsules ellipsoid, 16–20 mm, smooth, narrowed in proximal 5 mm and without seeds; seeds ellipsoid, smooth, glossy dark brown, ca. 2 × 1.3 mm, micropylar caruncle white, flattened, round or elongate and curved, ca. 0.8 mm long. Flowering in September to June.

Discussion. First collected in 1915 in the Arfak Mountains of western New Guinea, now West Papua, Indonesia, *Patersonia novo-guineensis* is now understood to extend from Mt. Angi in the west to Mt. Stolle in adjacent western Papua New Guinea to the east, always at high elevations, between 2000 and 3320 m. The species is recognized by the heavily brown-tomentose leaf margins, this accompanied by brown-tomentose spathe keels and lower margins, and floral bracts sometimes tipped with brown hairs. Only *P. lowii* has these organs with comparably dense vestiture. *Patersonia novo-guineensis* has in addition a perianth tube ca. 20 mm long, the lower part of which is densely covered with branched, brown hairs. The tepal tips also bear an apical tuft of hairs, a character unique in *Patersonia*. In *P. lowii* the perianth tube is ca. 25 mm long and smooth or at best sparsely short-hairy.

Like other species of Malesian *Patersonia* for which this is known, the seeds of *P. novo-guineensis* have a small white caruncle. Seeds of *P. lowii* are unknown. The second New Guinean species of the genus, *P. inflexa*, also has carunculate seeds, but the seeds, still poorly documented, are hooked at the micropylar end. This species also has a tomentose perianth tube, perhaps indicating shared ancestry, but it differs markedly in other features, including the inflexed flowering stem always exceeding the leaves, the smooth spathe margins and keels, and ciliate leaf, rather than margins of *P. novoguineensis*, which are conspicuously brown-tomentose.

One of the syntype collections of the plant that was subsequently identified as *Patersonia novo-guineensis* var. *auriculata* by Went (1924), *Lam 1670*, was examined by Van Royen (1979), who concluded that it was a species of Cyperaceae. A duplicate at L, designated as an isotype in unknown hand, is a poorly preserved specimen of *P. novo-guineensis* lacking flowers or intact fruit, although the decaying inflorescence spathes and leaves show the characteristic tomentose keels or margins of this species. The flowering stem is unusually short, half as long as the leaves, but such shortened stems are known in the species. For example, a collection from Angi in the Arfak Mountains, *Kanechira & Hatusima 13663*, consists of plants with one short stem to 5 cm and a second, normal-looking stem 12.5 cm long. The isotype (*Lam 1670*) does not show details of the perianth noted in the protologue of variety *auriculata* (perianth segments 15 mm long). The location of other duplicates of the type of variety *auriculata* is unknown to me, but the taxon cannot be a species of Cyperaceae with tepals as described in the protologue.

Additional specimens examined. INDONESIA. **Irian Jaya [West Papau]:** Manokwari, Iray, path to summit of Mt. Koebré, subalpine forest *R. J. Johns et al. 8037* (GH, K); Arfak Mtns., Angi, *R. Kanechira & S. Hatusima 13691* (GH), *13663* (GH, K); Tamrau Range E, Wamsuf area above Waumi River, *P. van Rooyen & H. Sleumer 7202* (K, L); Angi, top of Kobrei to Gita Lake, *E. A. Widjaja EAW 4341* (CANB, K); Mt. Kobreimot (Koebré), WSW from Testega, Anggi Lakes, *H. Sleumer & Vink BW14172* (BISH, CANB, L); Arfak Mtns., Lake Angi, *K. Gjellerup 1209* (K, L). PAPUA NEW GUINEA. **Morobe:** Mt. Amungwiwa, alpine grassland below summit, 13 June 1976, *P. van Royen 11128* (BISH, K, L). **West Sepik:** Mt. Stolle, ridge on W side of mtn., 2500 m, 2 Sep. 1994, *J. C. Regalado & Katik 1302* (GH).

5. **Patersonia philippinensis** Goldblatt, sp. nov. TYPE: The Philippines. Mindoro: Mt. Halcon, 14 Apr. 1991, *B. J. Stone et al. 16390* (holotype, BRIT!; isotype, BISH!).

Plantae *Patersoniae lowii* Stapf similes, sed ab ea caule 9–12 cm × ca. 0.8 mm lato, foliis 90–120 × 2.0–3.5 mm marginibus laevigatis, spathis inaequalibus interna 23–30 mm longa externa 20–24 mm longa atque carinis marginibusque spatharum et marginibus bractearum laevigatis distinguuntur.

Tufted perennials mostly 8–12 cm high; stems straight, compressed, oval in section, shorter than leaves, 10–12 cm × ca. 0.8 mm, enclosed by sheath of uppermost leaf to or almost to the base of spathes in fertile stems. Leaves several per shoot in 2 ranks, basal, exceeding flowering stems, 90–120 × 2.0–3.5 mm, leaves when dry obscurely striate, surface (with 20× magnification) and margins smooth. Rhipidial spathes unequal, inner 23–30 mm, outer 20–24 mm, keels and margins smooth; floral bracts dry-membranous, margins smooth. Flowers mauve or blue; no other floral or fruit details known. Flowering recorded in April.

Discussion. Although *Patersonia* has long been known from the Philippines, first from Mt. Halcon, Mindoro (Merrill, 1907), and recently from Mt. Hamiguitan, Mindanao (Amoroso et al., 2009), I have seen only one collection, from Mindoro. Evidently Merrill's collection from Mindoro, made in 1906, is lost, and there is apparently no voucher for the Mindanao record. Nevertheless, at least the Mindoro plant is clearly not *P. lowii*, the species to which it was provisionally assigned by Merrill. The leaves, no more than 15 cm high, consistently longer than the flowering stems, and 2–3 mm wide (vs. 3–4 mm wide in *P. lowii*), have smooth margins, and the spathe keels and margins and floral bracts are also smooth, thus unlike the prominently brown tomentum on these organs in *P. lowii*. Similarly, the subequal spathes of *P. lowii*, 36–40 mm long, are larger than the unequal spathes of *P. philippinensis*, in which the inner are 23–30 mm long and the outer are 20–24 mm long. Unfortunately, few floral and no fruit details are known, and little more can be said about the possible relationships of this new species. It would be useful to examine *Patersonia* from Mt. Hamiguitan as it is some 800 km from Mt. Halcon, but both peaks are about 900 km from the next nearest site for the genus, the Kinabalu Massif. Given the geographic patterns of speciation in *Patersonia*, the Mt. Hamiguitan plants may well be a separate species.

6. Patersonia sumatrensis Goldblatt, sp. nov. TYPE: Indonesia. Sumatra: Gunung Leuser National Park, Gunung Leuser (as Mt. Losir), Gajolands, acid, stony open ground in mtn. heathland, 2100–2250 m, 29 Jan. 1937, *C. C. van Steenis 8444* (holotype, L!; isotypes, CANB!, GH!, K!).

Plantae *Patersoniae lowii* Stapf similes, sed ab ea foliis 3–3.5 mm latis marginibus laevigatis, spathis inaequalibus interna 40–45 mm longa externa 35–40 mm longa, carinis marginibusque spatharum laevigatis, tubo perianthii laevigato atque ovario ca. 12 mm longo distinguuntur.

Tufted perennials 18–35 cm high; stems compressed, ?green, oval in section, 18–35 cm × ca. 1.5 mm, flexed above sheathing part of uppermost leaf and then usually slightly inclined. Leaves ca. 10 per shoot in 2 ranks, basal, mostly slightly exceeding flowering stem; blades 3–5 mm wide, when dry closely striate, surface (30× magnification) smooth or obscurely papillate (*de Wilde & de Wilde-Duyfjes 16390*), margins smooth, rounded, hyaline, uppermost leaf sheathing the lower half (to 2/3) of stem, apex reaching beyond upper 2/3 of stem. Rhipidial spathes orange-brown, unequal, inner 40–45 mm, outer ca. 35–40 mm, spathe keels and margins smooth; floral bracts dry-membranous, margins smooth. Flowers lilac-blue; perianth tube ca. 22 mm, smooth; outer tepals ovate, ca. 12 × 7.5 mm, inner tepals ?lacking; filaments united in a column ca. 1.5 mm; anthers ca. 2 mm; ovary ellipsoid, ca. 12 mm, smooth; style dividing at apex anthers, stigma lobes unknown. Capsules ellipsoid, ca. 20 mm long, smooth; seeds ellipsoid, smooth, glossy dark brown, obscurely striate, ca. 2 × 1 mm; micropylar caruncle white, flattened, ovate, appressed to surface ca. 0.5 mm long. Flowering recorded in January and April.

Discussion. Endemic to the high mountains of northern Sumatra in Indonesia, *Patersonia borneensis* is evidently restricted to high elevations on Gunung (Mt.) Leuser in the Gunung Leuser National Park. Van Steenis, who made the first collection in 1937, noted that he found no trace of the plant on nearby mountains. It can be distinguished from other Malesian species of *Patersonia* by the absence of vestiture or any kind on the leaves, spathes, and floral bracts. Even the perianth tube is completely hairless. In one collection, *de Wilde & de Wilde-Duyfjes 16390*, papillae are visible on the leaf surface at 30× magnification but not as clearly as in *P. borneensis*, the only other Malesian species with minutely papillate leaf surfaces. The general aspect of *P. sumatrensis* most closely approaches that of *P. lowii*, especially in height, but the somewhat narrower leaves usually slightly exceed the stem, which is weakly flexed above the sheathing portion of the uppermost leaf, a feature recalling the otherwise rather different *P. inflexa* of eastern Papua New Guinea.

Paratypes. INDONESIA. **Sumatra:** Gunung Leuser Nature Reserve, W top of Gunung Leuser, 2200–2700 m, 4 Apr. 1975, *W. J. J. de Wilde & B. E. E. de Wilde-Duyfjes 16074* (fr.) (K, L); 13 Apr. 1975, *W. J. J. de Wilde & B. E. E. de Wilde-Duyfjes 16390* (K, L); Mt. Leuser, *Dillon Ripley s.n.* (PH).

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